Comment by Greenwood Telecommunications Consultants LLC

In the Matter of

Office of Engineering and Technology Recommendations by Technical Advisory Committee (TAC)

ET-17-340

Introduction

Greenwood Telecommunications Consultants LLC, Denver and Boulder CO, appreciates the Commission affording opportunity to comment on a critical matter. Greenwood provides technical, economic and strategic management consulting services to wireless industry clients. Greenwood has been active with spectrum management issues regarding compatible re-purposing the L Band spectrum, especially that proximate to GPS (1559-1610 MHz) L1 ARNSS band, and other spectrum management areas such as the 3.5 GHz CBRS Shared Spectrum proceeding, and AWS-1 spectrum re-purposing from exclusively satellite to shared terrestrial and satellite use. It served on the FCC's TWG expert group in 2011 to evaluating interference potentially posed by the LightSquared LLC terrestrial ATC transmission proposal with prospective impact to GPS receivers and systems.

In this proceeding, the FCC OET seeks comments to its TAC recommendations regarding application of formal principles by the FCC TAC to resolve interference and promote compatibility. Recent and upcoming examples of inter-system operations include radar, radio navigation (GPS, GNSS, DME, TACAN), and federal government agency proprietary radio systems. Each of these are operating closer to mobile LTE as spectrum is re-purposed to ubiquitously support these new, bandwidth intensive mobile service providers. We concur with the principles presented by the TAC and they appear appropriate to continue the transition toward more crowded, more competitive spectrum management and operations. In some respects, this is critical to national security of critical infrastructure and in other areas, these policies affect our vigilance in safety of life systems. We also believe the principles must be accompanied by a definitive, accountable process which is designed to thoroughly quantify, resolve, prevent interference, and if it arises there are credible enforcement rights to interdict transgressors.

At Issue

The FCC TAC through the OET NOI provides nine spectrum management principles deemed essential to increase available spectrum while avoiding harmful interference following explicit transmit mask and corresponding receiver adjacent band rejection compatibility performance principles. Among the nine TAC principles introduced, at least one formally places responsibility on legacy receiver performance, in particular, its capability to reject adjacent band transmissions that create a loss of performance due to a receiver's response to any set of adjacent signals that leads to disruptive interference ("ABI").

Thus the nine TAC principles in unison seek to bring attention by seeking stringent specifications for receivers to amply reject interference presumably against any combination of neighboring transmissions

at once. To this end, the principles hopefully lead to a process that 1) formally establishes tolerable range and frequency separations for both transmitters and receivers, transmission EIRPs, and in various cases, gain and beam width patterns of receiver and transmit antennas, 2) creates reliable adjacent band receiver rejection criteria for mobile and base units arising from adjacent, off-desired signal[1] incident power and frequency offset, which is generally referred to as a receiver adjacent band rejection mask.

The TAC principles however meritorious as prescriptive of policy have in less formal settings proved challenging to implement in spectrum re-purposing proceedings. The past 15-20 years' experience with respect to spectrum re-purposing – to increase availability of wideband mobile spectrum -- shows much improvement is still required to ensure successful transitions toward more efficient, thus re-purposed spectrum, and do so economically and without disturbing legacy services. We focus here on defining a process satisfying new and legacy spectrum stakeholders following the TAC's nine principles and which achieves post transition outcomes of greater spectrum utilization and avoiding harm to legacy services.

Systematic, Open Stakeholder Process to Determine Transitional Compatibility in Spectrum Re-Purposing Management

Initial Conditions, Discovering Prospective Cross-band Compatibility Requirements

Re-purposing cases have many positive but under-managed can potentially create even worse negative impacts. Re-purposing positively "densifies" spectrum resulting in additional traffic capacity per MHz deployed and do so where it's most needed, primarily in densely populated, active metro areas. Spectrum re-purposing may be one of the most important tasks the FCC will handle in the next 10-20 years as mid-range spectrum, nominally between 1 and 6 GHz as lower density bands plan transition from mostly single-purpose to multi-purpose, denser operations.

This transition will exhibit certain predictable characteristics. Once "quiet" legacy stakeholders will sense pressure from neighboring stakeholders as surrounding services grow, and spectrum is more densely packed thus increasing odds of interference. To combat rising interference, the transition process should actively move from reactive to proactive and more formally observed governing steps such as multiple stakeholder forums (MSF). The MSF can with expertise target discovery of interference prior to errant deployments and expose challenges regarding managed spectrum re-purposing transitions. It can determine legitimate compatibility standards and best assess within a peer review process re-purposing benefits, needs, costs, and timing or propriety of equipment upgrades.

Due to their economic or competitive pressures, new broadband mobile operations will seek to access re-purposed bands as soon as possible. It is important to ensure the forum engages both legacy and new spectrum operating cases with prospective, mutually responsive actions designed to lower incompatibilities.

[1] This reference is to distinguish from on-channel forms of receiver interference that arise from either OOBE, out of band emissions, or intermodulation where a intermodulation "spur" on-channel product which arises from the presence of two or more neighboring signals, typically located relatively near a victim receiver.

MSF Participation, Goals

However well intended the TAC principles, without a stakeholder governance process to reduce the principles to practice tensions among stakeholders will likely frustrate or up-end the principles unless both legacy and new service interests are jointly "at the table" informed openly, diligently and transparently.

Spectrum re-purposing and final rules setting spectrum allocation require multiple parties and expertise from the stakeholders and the radio regulator, and likely the Federal government which holds much of the to-be re-purposed spectrum today. The process should adhere to good MSF governance practices that score or account to the FCC and TAC principles carefully with measurable increases in spectrum efficiency. The process should expect equitable balancing of the legacy services' rights to interference-free operation, mutually accept responsibility to meet higher spectrum efficiency through compatible design or upgrade arrangements, which begins no later than the time new allocants enter.

Proposed use cases vary, but a common case is deployment of dense terrestrial mobile broadband services involving more cleared LTE or 5G use cases. These cases are among the highest in terms of contiguous spectrum demand.

Since spectrum in the mid-range is well known to be suit efficient coverage and traffic density parameters, and provides important connectivity to rising number of licensed and unlicensed IoT applications, it will require concerted action by all stakeholders to create the least impact or burdensome transition on legacy services, properly gauge the extent of fielded receiver performance, ascertain readiness or economic feasibility of swap or module substitution of incompatible receivers should those upgrades be warranted (if otherwise commercially feasible), organizing economic equipment upgrades during transitions, creating attentive awareness from spectrum stakeholders to avoid or minimize end-user impacts, maintain high performance across legacy services or operations while undergoing transition from the previous to new spectrum access equipment without incurring harmful interference to legacy equipment.

Fitting Spectrum Realities to Post Spectrum-Transition Objectives

We briefly summarize the factors, or as the TAC refers to them as the realities, that must be within reach of stakeholders and regulatory representatives to manage the spectrum re-purposing process that successfully transitions spectrum across affected stakeholders.

Primary spectrum forces at work in a well governed process following TAC principles

Re-purposing involves concurrently reconciling pressures leading toward spectrum re-purposing. These include harmonizing international with domestic regulatory rules, capturing advantageous equipment or technology benefits, matching or harmonizing global standards, matching new generation performance and applications, developing an orderly transition which achieves higher device density and traffic consistent with increasing spectrum return on investment, and as stated above, ensure legacy services are spared negative impacts during or after spectrum re-purposing transitions.

Vetting spectrum re-purposing proposals through an MSF governance process

New proposals are complete if they fully define a feasible spectrum budget, tie timely access of re-purposed spectrum in accord with capacities that match current occupants receive systems

compatibilities, have an economic budget to incentivize upgrade should legacy systems require additional adjacent band rejection performance.

Vetting counter-proposals

New proposals will likely generate counter-proposals coming in with diverse perspectives. The process will therefore have to confront and at times mediate counter proposals which must balance against the originating proposal. Divergent views which perceive differences in spectrum compatibility or operating conditions, time or cost to implement feasibilities among other factors all have to be weighed. The counters must be mediated through an equally transparent accountable and empowered MSF process. Among the requirements for uniform transparency is to undertake testing using unbiased measures, and if it is to resolve technical controversies use independent lab and measurement services following best practices.

Economic counter proposals should also attempt to narrow analytical differences as much as possible by showing cost-benefit performance relative to a more or less pre-set common or agreed baseline case or scenarios.

Summary and Recommendations

To ensure the FCC TAC's nine principles achieve traction leading to new spectrum with satisfactory results, we encourage the OET initiate timely Multi-Stakeholder Process (MSF) as new re-purposing proposals ready for MSF scrutiny are introduced, and do so across each band region following best practices when it appears re-purposing will increase feasibly spectrum efficiency.

1. Inclusively draw stakeholders. This encourages both close-in and "wide angle" perspectives on cross-band interference mitigation and exposes opportunities for greater efficiency.
2. MSF saves time and avoids test and transparency failures: MSF governance adoption assures commitment to a common rule set, stakeholder equality, open and witnessed testing, uniform test procedures following best practice.
3. Recognize transitional realities up-front. Newly deployed receivers may lack capacity to handle future re-purposing without steps to anticipate future spectrum allocations.
4. Certain categories of legacy receivers have especially long lifetimes such as those deployed in military or aviation radar infrastructures. Updating while feasible for new-build systems could trail by years realization in the field. These cases require strategic spectrum roadmaps to encourage less transition time.
5. Legacy receiver suppliers have historically not had economic incentives to drive adjacent band immunity to the lowest point. While the TAC principles point out the receiver's role in assured compatibility, without existing explicit practices which the TAC encourages it may be difficult to achieve more favorable transition cost.
6. Avoid "Customer in the middle" conflicts. Since end-customers buy and do not design radio systems thus might become by-standers in adjacent band interference controversies, it appears a new approach is needed at the regulatory level as well. Customers assume their suppliers will design to avoid all forms of interference – even where a lawfully operating transmitter is not the true cause of interference. Customers likely assume that regulators devise rules that protect,

thus limit adjacent transmission OOBE's which based on current analysis is not often the case. When there is inadequate rejection there is a tendency to automatically blame new transmissions or operations rather than ensure both receiver and transmitters are designed for efficient compatibility. To raise customer awareness of efficient spectrum usage, we recommend receiver suppliers as part of type acceptance are compelled to opt in or out (and in the latter case, disclose the lack of) conformance to industry based adjacent mask standards. Like Part 15 notice, the customers should know what the relative immunity the receivers offer within certain typical operating limits.

7. Handle multiple services, each mutually close in frequency, within the same re-purposing proceeding. Spectrum updates typically affect more than one stakeholder sharing neighboring bands. An example is a versatile, multi-faceted L Band which features MSS, AMT, GPS, NOAA weather satellite systems bands and more recently across the globe now includes new terrestrial LTE services. To successfully transition, the lesson learned in the fiasco within the recent attempt to transition and re-purpose partially the L Band reveals services must be concurrently aware and upgraded in coordinated fashion to realize increased spectrum use.
8. Following best practices such as Harm Claim Threshold policies, receiver suppliers should be voluntarily encouraged to seek enforceable rights which create interference protection should submit to reaching maximum feasible adjacent band "mask" (frequency separation versus adjacent transmission EIRP) performance.
9. Make current statutes and rules related to adjacent band operations and interference protections less or non-ambiguous to encourage increased practical efficiency without inducing adjacent band interference.
10. Encourage participation blind to stakeholder size, economic position or power. Neutralize efforts to bias the process or diminish test transparency.

Respectfully submitted,

Greenwood Telecommunications Consultants LLC
rlee@greenwoodtel.com